

Multimethod Assessment of Attention-Deficit Hyperactivity Disorder: The Diagnostic Utility of Clinic-Based Tests

By: George J. DuPaul, Arthur D. Anastopoulos, [Terri L. Shelton](#), David C. Guevremont & Lori Metevia

DuPaul, G.J., Anastopoulos, A.D., Shelton, T.L., Guevremont, D.C., Metevia, L. (1992). Multimethod assessment of Attention Deficit Hyperactivity Disorder: The diagnostic utility of clinic-based tests. *Journal of Clinical Child Psychology* (now called *Journal of Clinical Child and Adolescent Psychology*), 21(4), 394-402.

Made available courtesy of Taylor & Francis (Routledge) <http://www.routledge.com/>

The original publication is available at http://dx.doi.org/10.1207/s15374424jccp2104_10

*****Note: Figures may be missing from this format of the document**

Abstract:

Investigated the utility of two clinic-based tests, the Matching Familiar Figures Test (MFFT; Kagan, 1966) and a version of the Continuous Performance Test (CPT; Gordon, 1983), in the assessment of children with attention-deficit hyperactivity disorder (ADHD). At a group level of analysis, scores on the CPT and MFFT were found to share little variance with parent and teacher report on several behavior rating scales used to evaluate ADHD. Further, clinic test scores, either alone or in combination, resulted in classification decisions that frequently disagreed with a diagnosis of ADHD based on parent interview and behavior-rating-scale data. The limited utility of currently available tests in the evaluation of ADHD suggests the need to develop clinic-based measures of sufficient ecological validity, which can be used in conjunction with parent and teacher report.

Article:

Attention-deficit hyperactivity disorder (ADHD; American Psychiatric Association, 1987) is one of the most common disorders of childhood wherein an individual exhibits significant problems with attention span, impulse control, and motor activity level relative to similar-age peers. A multimethod assessment approach is typically recommended for diagnosis and treatment planning (Barkley, 1990; Schaughency & Rothlind, 1991). Multimeasure assessments include a diagnostic interview with the parent, completion of behavior rating scales by the parent and teacher, direct observations of behavior, and administration of clinic-based tests (see Barkley, 1988b, for details of assessment). Multiple assessment techniques are used to determine the presence and severity of ADHD symptoms across settings, tasks, and caretakers, and to rule out other conditions that may account for the child's attentional problems (e.g., overanxious behavior).

Standardized, clinic-based measures of sustained attention and impulse control have been incorporated routinely into the diagnostic evaluation of ADHD. Purportedly, they provide objective data less influenced by factors (e.g., parental psychopathology) that might bias parent and teacher report (Barkley, 1987; Gordon, 1986). When normative data for such tests are available, they also afford the opportunity to compare a child's performance under standardized conditions to that of his or her normal counterparts (Barkley, 1987).

The most popular clinic-based measure of sustained attention and vigilance is the Continuous Performance Test (CPT; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956). Several different CPT versions are available. Most require the child to observe the rapid presentation of letters or numbers on a screen and to make a response (e.g., press a button) when a certain pair of stimuli appears in succession (Conners, 1985). Typically, three scores are derived: (a) the total number of correct responses, (b) the number of target stimuli missed (omission errors), and (c) the number of nontarget stimuli to which the child responded (commission errors). The total correct and omission error scores are seen as measures of sustained attention whereas the commission error score purportedly assesses both vigilance and impulse control (Sostek, Buchsbaum, & Rapoport, 1980). As a

group, children with ADHD exhibit higher frequencies of omission and commission errors relative to normal controls (Barkley, DuPaul, & McMurray, 1990; Fischer, Barkley, Edelbrock, & Smallish, 1990; Halperin et al., 1988; Klee & Garfinkel, 1983; Sykes, Douglas, & Morgenstern, 1973). Further, significant correlations between CPT scores and teacher ratings of inattention, impulsivity, and hyperactivity have been obtained, thus providing some evidence of the ecological validity of these measures (Halperin et al., 1988; Klee & Garfinkel, 1983; Shapiro & Garfinkel, 1986).

The Matching Familiar Figures Test (MFFT; Kagan, 1966) is one of the most widely employed measures of impulsivity in child psychology (Douglas & Peters, 1979; Milich & Kramer, 1984). Children are asked to choose from six similar pictures of familiar objects (e.g., cat) the one that is identical to a target stimulus. Twelve separate trials are administered with two scores derived: (a) mean latency to initial response and (b) total number of errors. It is assumed that a short latency to initial response combined with a high number of errors is representative of a "fast, inaccurate or impulsive response style (Mulch & Kramer, 1984). In fact, normative data are available for both MFFT scores (Salkind & Nelson, 1980), and a median split (i.e., faster-than-average mean latency and higher-than-average number of errors) is typically used to identify children as being impulsive (Milich & Kramer, 1984). At least one study (Brown, 1982) found children with ADHD to exhibit a significantly shorter latency and a greater number of errors than normals, but most investigations have found group differences for the error score only (Brown & Wynne, 1984; Homatidis & Konstantareas, 1981; Milich & Kramer, 1984). Further, MFFT scores have been found to correlate significantly with the Hyperactivity factor score on the Child Behavior Checklist (Fuhrman & Kendall, 1986).

Although scores on the CPT and MFFT appear to discriminate between children with ADHD and their normal counterparts at a group level, the utility of these measures in assessing individual children is limited by several factors. First, several investigations have failed to obtain significant correlations between criterion measures (e.g., teacher ratings, other laboratory measures of vigilance and impulsivity) and scores on various CPTs (Halperin, Sharma, Greenblatt, & Schwartz, 1991; Lovejoy & Rasmussen, 1990) or the MFFT (Barkley, 1991; Brown, 1982; Milich & Kramer, 1984). Second, when the effects of age, sex, and receptive vocabulary skills have been partialled out, scores on these measures have failed to discriminate among children with ADHD, conduct disorder, anxiety disorder, and their normal peers (Werry, Elkind, & Reeves, 1987). Given its high correlation with IQ, the MFFT in particular has been criticized as being merely a crude measure of cognitive ability rather than an index of impulse control (Milich & Kramer, 1984). Third, even when the effects of age, sex, and IQ have not been partialled out, scores on these two clinic-based tests have not reliably discriminated among different groups of clinic-referred children (Campbell, 1974; Halperin et al., 1990; Shapiro & Garfinkel, 1986). Finally, when significant correlations have been obtained between MFFT and CPT scores and criterion measures, these have typically been of low magnitude (i.e., between absolute values of .21 and .50) suggesting that the results of clinic-based tasks may account for minimal variance (i.e., 20% to 30%) of criterion indices (Barkley, 1991).

These limitations have led some investigators to question the ecological validity of the CPT and MFFT (Barkley, 1991) as, well as the relevance of these measures to diagnostic evaluations of children referred because of ADHD symptoms (Halperin et al., 1991; Schaughency & Rothlind, 1991). Prior investigations have primarily examined the utility of these tests at a group level of analysis. In contrast, most mental health practitioners are interested in the ability of CPTs and the MFFT to determine whether an individual child might have ADHD. When used in the context of a multimodal assessment paradigm, do these measures provide diagnostic data that are consistent with other components of the evaluation (e.g., parent interview responses, teacher ratings)? Very few studies have investigated this important clinical issue. Gordon, DiNiro, and Mettelman (1988) found that the diagnostic "hit rate" of CPT scores agreed with classifications based on parent and teacher ratings for approximately 50% of a large sample of clinic-referred children. Unfortunately, this finding has not been independently replicated nor extended to MFFT diagnostic data.

The purpose of this investigation was to determine the degree to which scores on a CPT and the MFFT agreed with parent and teacher ratings in a sample of children referred to an outpatient clinic specializing in ADHD.

Specifically, this study examined the concordance of ADHD diagnoses, derived from clinic test results and from parent and teacher ratings of child behavior.

Method

Subjects

Subjects were 68 consecutive referrals to an outpatient psychiatry clinic specializing in the assessment of ADHD. The sample included 58 boys and 10 girls, ranging in age from 72 to 143 months ($M = 103.5$ months, $SD = 18.6$ months). All children attended public-school classrooms, ranging from kindergarten through sixth grade. Subjects were from families spanning all socioeconomic strata, with most from the middle class as determined by the Hollingshead Index (Hollingshead, 1975). The majority of children were Caucasian, with 10% of the sample either Hispanic or African-American.

All children met the following criteria:

1. A diagnosis of ADHD using criteria set forth in the Diagnostic and Statistical Manual of Mental Disorders (3rd ed., rev.; DSM-III-R; American Psychiatric Association, 1987), including parent report of 8 or more symptoms of ADHD, onset of symptoms prior to age 7, and duration of symptoms greater than 6 months.
2. Either a parent rating on the Hyperactivity factor of the Child Behavior Checklist (Achenbach & Edelbrock, 1983) or a teacher rating on the Child Attention Problems Scale (CAP; Barkley, 1988a) greater than the 93rd percentile (i.e., T score equal to or greater than 65) for the child's sex and age.
3. Functioning in at least the low-average range of intelligence based on school-based IQ testing conducted during the previous year, using the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974) or clinic-based screening using the Vocabulary subtest of the WISC-R.
4. No evidence of deafness, blindness, severe language delay, cerebral palsy, epilepsy, pervasive developmental disorder, or psychosis as established through medical history, parental interview, and child observation.

In addition to the diagnosis of ADHD, 19 children (i.e., 27% of the sample) were diagnosed as having oppositional-defiant disorder and 7 children (10%) received an additional diagnosis (e.g., conduct disorder) other than oppositional-defiant disorder.

Parent Ratings

Mothers completed two questionnaires.

Child Behavior Checklist (CBCL). The CBCL (Achenbach & Edelbrock, 1983) yields T scores for narrow-band and broad-band scales tapping a variety of internalizing and externalizing behavior. T scores on the Externalizing and Hyperactive scales were used as dependent measures in this study. The reliability and validity of the CBCL are quite satisfactory (see Achenbach & Edelbrock, 1983; Barkley, 1988c).

Home Situations Questionnaire (HSQ). The HSQ (Barkley & Edelbrock, 1987) measures the pervasiveness of child behavior problems across 16 separate home situations. Two scores were used as dependent measures: (a) number of problem situations and (b) mean severity of behavior problems. The reliability and validity of this questionnaire are satisfactory (see Altepeter & Breen, 1989; Barkley & Edelbrock, 1987).

Teacher Ratings

Each child's primary teacher completed three scales.

Child Behavior Checklist-Teacher Report Form (CBCL-TRF). The CBCL-TRF (Achenbach & Edelbrock, 1986) is an 118-item questionnaire that has comprehensive normative data and adequate psychometric properties (see Barkley, 1988b). T scores on the Externalizing, Inattentive, and Nervous—Overactive subscales were used.

School Situations Questionnaire (SSQ). The SSQ (Barkley & Edelbrock, 1987) is a checklist assessing the pervasiveness of behavior problems across 12 school situations. Two scores were used in the data analyses: (a) number of problem situations and (b) mean severity of behavior problems. This checklist has been found to possess adequate levels of reliability and validity (Altepeter & Breen, 1989; Barkley & Edelbrock, 1987).

ADHD Rating Scale. This scale (DuPaul, 1991) consists of 14 items directly adapted from the ADHD symptom list in the most recent edition of DSM-III-R (American Psychiatric Association, 1987). Teachers indicated the frequency of each symptom on a 4-point Likert scale ranging from not at all (0) to very much (3) with higher scores indicating greater ADHD-related behavior. This scale has been found to have adequate internal consistency and test—retest reliability, to correlate with criterion measures of classroom performance (DuPaul, 1991), and to be sensitive to psychostimulant medication effects (Barkley, DuPaul, & McMurray, 1991). Three scores were used in the present study: (a) the total raw score, (b) the Inattention-Hyperactivity factor score, and (c) the Impulsivity-Hyperactivity factor score.

Clinic-Based Tests

Continuous Performance Test (CPT). The Gordon Vigilance Task (Gordon, 1983) was used as the CPT for this study. It is a 9-min task during which numbers are presented on a display screen at the rate of 1 per second. The stimulus number remains for 800 msec with a 200-msec delay between stimuli. The child is told to watch the screen and press a large blue button on the display panel whenever a 1 appears followed by a 9. This target pair is presented a total of 45 times during the testing. Two scores were used in this study: (a) total correct responses and (b) commission errors. This version of the CPT was used because normative data for over 2,000 children from the normal population are available. Adequate levels of test-retest reliability have been reported for both scores (Gordon, 1983).

Matching Familiar Figures Test (MFFT). The MFFT (Kagan, 1966) is a commonly used measure of impulse control in which a child is shown a page containing a sample picture, below which are six very similar pictures. The child is to point to the picture that is identical to the sample picture. If mistaken, the child tries again until the correct picture is identified. Twelve trials are presented. Two scores were used: (a) mean latency to initial response and (b) total number of errors across trials.

Procedure

Each child's mother completed the CBCL and HSQ to determine eligibility for the study and as part of the collection of dependent measures. Each child's primary teacher completed the CAP Rating Scale to determine eligibility for the study. The teacher rating scales used as dependent measures (i.e., CBCL-TRF, SSQ, and ADHD Rating Scale) were completed at the same time as the CAP. Eligible children and their mothers were then seen on a single day during which the MFFT and the CPT were administered. The order in which the tests were administered was randomly determined for each child. Prior to testing, mothers were interviewed to determine whether DSM-III-R (American Psychiatric Association, 1987) criteria for ADHD were met using the semistructured interview employed by Barkley (1990). Testing was conducted by the same psychologist who interviewed the mother. The examiner was not present in the testing room while the child completed the CPT to control for compliance effects, which have been obtained in other studies (e.g., Draeger, Prior, & Sanson, 1986).

Each child's CPT score was classified as being in the ADHD (at or beyond the 93rd percentile) or normal (less than the 93rd percentile) range, based on normative data (Gordon, 1983). The 93rd percentile was adopted as the classification cutoff to conform with the cutoffs employed on the parent and teacher rating scales. A child's performance on the MFFT was characterized as "fast, inaccurate" or impulsive using a median-split method (Milich & Kramer, 1984). If the mean latency score was below the median for age and sex and the total error score was above the median for age and sex using norms developed by Salkind and Nelson (1980), a child's performance was classified in the ADHD range. If a child's performance did not meet the previous criterion, it was characterized as nonimpulsive (i.e., non-ADHD).

Results

The relations between clinic test scores and data obtained from other components (i.e., parent and teacher ratings) of the ADHD evaluation were examined at group and individual levels of analysis. First, correlations between clinic test scores and rating scale data were calculated for the entire sample. Next, the percentage agreement of classification decisions between clinic-based tests (CPT and MFFT) and criterion measures was examined across individual children for varying combinations of test scores.

Correlational Analysis

Prior to conducting the correlational analysis, raw scores for all variables (except scores on the parent CBCL and teacher CBCL—TRF which were in T-score form) were standardized for age and sex by converting to T scores using means and standard deviations from the normative, sample for each measure. Pearson product-moment correlation coefficients between scores obtained on the clinic tests (i.e., CPT and MFFT) and the parent and teacher rating scales are displayed in Table 1. An alpha level of .01 was employed given the number of coefficients obtained. All these correlations were nonsignificant ($p > .01$), indicating minimal association between clinic-based test scores and ratings on parent and teacher questionnaires. Further, the maximum variance shared between clinic-based test scores and the criterion measures was 7.3% (i.e., a correlation of $-.27$ between MFFT latency and the Impulsivity-Hyperactivity factor on the ADHD Rating Scale).

Table 1. *Correlations Between Clinic-Based Test Scores and Criterion Measures*

Criterion Measure	CPT Total Correct	CPT Commission Errors	MFFT Mean Latency to Initial Response	MFFT Total Errors
CBCL—Hyperactivity	-.07	-.02	.07	.08
CBCL—Externalizing	.01	.02	.06	.09
HSQ—Number	.11	-.24	.09	-.05
HSQ—Severity	-.01	.00	.02	.02
TRF—Inattention	-.08	-.18	-.10	.03
TRF—Overactivity	.06	-.10	.02	.02
TRF—Externalizing	-.22	-.07	-.06	.12
SSQ—Number	-.09	.02	-.05	.04
SSQ—Severity	-.12	.01	-.12	.10
ADHD—Inattention	-.09	-.10	-.14	.08
ADHD—Impulsivity	-.15	.08	-.27	.24
ADHD—Total	-.14	.01	-.24	.19

Note: HSQ—Number = HSQ, number of problem situations; HSQ—Severity = HSQ, mean severity; SSQ—Number = SSQ, number of problem situations; SSQ—Severity = SSQ, mean severity; ADHD—Inattention = ADHD Rating Scale, Inattention—Hyperactivity factor; ADHD—Impulsivity = ADHD Rating Scale, Impulsivity—Hyperactivity factor; ADHD—Total = ADHD Rating Scale, total score.

Clinic Test Scores: Classification of Children as ADHD

Children's scores on the CPT and MFFT were classified as being in the ADHD or non-ADHD range in accordance with criteria outlined in the Method section. Specifically, CPT scores were classified as being in the ADHD range if they were above the 93rd percentile relative to age-based norms. A double median-split was used for MFFT scores wherein the ADHD range was defined as mean latency scores below the 50th percentile and total errors above the 50th percentile for the child's age and sex. The level of agreement between classifications made on the basis of clinic-based testing and criterion measures was assessed for each test score and their various combinations as displayed in Table 2.

The percentage agreements between clinic test scores and criterion measures in classifying children as ADHD ranged from 11.8% to 61.8% depending on the combination of scores utilized (see Table 2). When clinic test scores were used in isolation (initial three rows in Table 2), percentage agreements ranged from a low of 22% for CPT total correct score to a high of 51.5% for the MFFT double median-split. The percentage of classification agreements was significantly greater for the MFFT double median-split than for the CPT total correct score, $\chi^2(1, N = 68) = 15.89, p < .001$. No further significant differences in agreement rates were obtained. The greater hit rate for the MFFT may simply reflect the use of a more liberal criterion (i.e., the 50th

percentile) than was employed for the two CPT scores. When classification was based on a child obtaining scores in the ADHD range on both CPT measures, the agreement rate dropped to 13.2%.

Table 2. *Agreement of Classification Decision Between Clinic-Based Test Scores and Criterion Measures*

Clinic Test Score	Classification of ADHD Based on Criterion Measures	
	Agree	Disagree
CPT correct ^a	15 (22%)	53 (78%)
CPT error ^b	24 (35.2%)	44 (64.8%)
MFFT median split ^c	35 (51.5%)	33 (48.5%)
CPT correct <i>or</i> error	30 (44.1%)	38 (55.9%)
CPT correct <i>and</i> error	9 (13.2%)	59 (86.8%)
CPT correct <i>or</i> error <i>or</i> MFFT median split	42 (61.8%)	26 (38.2%)
CPT correct <i>and</i> error <i>or</i> MFFT median split	36 (52.9%)	32 (47.1%)
CPT correct <i>or</i> error <i>and</i> MFFT median split	23 (33.8%)	45 (66.2%)
CPT correct <i>and</i> error <i>and</i> MFFT median split	8 (11.8%)	60 (88.2%)

^aCPT total correct score. ^bCPT commission errors. ^cAbove the median for errors and below the median for latency to initial response on the MFFT.

Several combinations of CPT and MFFT scores were used to classify children as ADHD or nonADHD to reflect typical clinical practice of attempting to integrate test data to reach diagnostic decisions. The most liberal classification scheme was defined as the child's performance being in the ADHD range on any of the three clinic test scores. This resulted in the highest level of agreement with criterion measures (61.8%); however, nearly 40% of the children diagnosed as having ADHD were not correctly identified using this relatively liberal classification paradigm. Using the most stringent test combination, where the child's scores fell within the ADHD range on both the CPT and MFFT, only 11.8% of the sample was correctly classified (see last row in Table 2). It is important to note that the varying combinations of test scores resulted in highly discrepant agreement rates with criterion measures, thus implicating the need to define more specific decision rules for classifying children as ADHD when using these clinic tests.

Discussion

The results of this investigation provide further evidence of the limited ecological validity of traditional clinic-based measures in the diagnostic assessment of children referred for an evaluation of possible ADHD. At a group level of analysis, scores on the CPT and MFFT were found to share little variance (i.e., a maximum of 7.3%) with parent and teacher report on several behavior rating scales typically used in the assessment of ADHD. In fact, all the obtained correlations between clinic tests and behavior rating scales were nonsignificant. More important, clinic test scores, either alone or in combination, resulted in classification decisions that frequently disagreed with a diagnosis of ADHD based on parent interview and behavior-rating-scale data. The percentage agreement between classifications rendered by clinic test scores and a diagnosis of ADHD based on parent and/or teacher report ranged from 11.8% to 61.8%, depending on the combination of test scores utilized.

When employing the most liberal criterion for classifying children as ADHD based on test performance, nearly 40% of a sample of children diagnosed with ADHD were not classified as such by the CPT or MFFT.

The correlations between behavior ratings and scores on the CPT and MFFT obtained in this study were lower than those reported in previous investigations. Significant correlations between scales related to ADHD symptoms on various behavior rating scales (e.g., CBCL, Conners Rating Scales) and MFFT latency and error scores have typically been in the .20 to .40 range (Barkley, 1991; Fuhrman & Kendall, 1986). Similarly, previous studies have obtained correlations between behavior ratings and CPT scores in the .25 to .51 range (Barkley, 1991; Halperin et al., 1988; Klee & Garfinkel, 1983; Pascaulvaca, Wolf, Healey, Tweedy, & Halperin, 1988). This discrepancy with previous research may have been due to the restricted range of the dependent variables because a clinic-referred sample was used. Further, the use of a different CPT than was employed in other studies may have contributed to this finding. In a related manner, some of the previous investigations used a D' score as the primary dependent measure for the CPT, thereby controlling for "noise" in the data. Finally, the CPT scores used in this study did not take into account possible deterioration in attention over time, thereby possibly limiting correlations with behavior ratings of sustained attention. Nevertheless, the percentage of variance shared between clinic test scores and behavior ratings has been relatively small (e.g., 5% to 15%) in most studies which is consistent with the present results in indicating a minimal relationship between these tasks and ratings of home and school behavior.

Gordon et al. (1988) found that 52% of a large sample (N = 74) of children diagnosed as ADHD on the basis of abnormal range scores (i.e., ratings at or beyond the 90th percentile) on the Hyperactivity factor of the CBCL and/or the Inattention factor on the CBCL-TRF also obtained abnormal CPT commission error scores. This level of agreement is greater than was obtained for the CPT commission error score (Le, 35.2%) in this study. This discrepancy in results between the two studies is probably due to two factors. First, children in the present sample were classified as ADHD on the basis of meeting DSM-III-R criteria on parent interview responses and receiving abnormal range scores on either the CBCL or CBCL-TRF. Parent interviews with respect to DSM-III-R criteria were not employed by Gordon et al. (1988). Second, the cutoff point for the abnormal range on the CBCL, CBCL-TRF, and CPT in the present study was the 93rd rather than the 90th percentile. Thus, the use of more stringent classification criteria may have reduced the number of agreements between CPT-based and criterion-based diagnoses.

Diagnostic classification agreement was higher using the MFFT median split than any combination of CPT scores. Rather than being indicative of the superiority of the former in the diagnosis of ADHD, this result may simply reflect the use of a more liberal criterion for abnormality (i.e., the 50th percentile) than was used for CPT scores (93rd percentile). Despite the use of this liberal criterion, almost 50% of the ADHD sample was not identified as abnormal on the MFFT. Because nearly half of a sample of children with ADHD did not score in the abnormal range on these measures, the MFFT and CPT do not appear suitable as initial screening measures for individual children, especially when used in isolation.

The degree to which diagnostic classifications based on clinic tests and criterion measures were in agreement varied widely as a function of the specific test, scores used. In fact, there was as much as a 50% difference in agreement rates depending on the combination of scores employed (see Table 2). This discrepancy suggests that if clinic-based tests are to be reliably used in the diagnostic assessment of ADHD, then there must be some a priori guidelines for combining test scores to render a classification decision. The results of this study suggest that the greatest consistency with other measures would be obtained if a child is classified as ADHD for the clinic testing component of the assessment, if he or she obtained scores at or beyond the 93rd percentile on any of the CPT or MFFT indices. Furthermore, a larger battery of clinic-based tasks may be necessary to capture additional variance.

There are several possible reasons for the minimal agreement between clinic-based test scores and parent and teacher ratings. First, the CPT and MFFT may provide information about inattention and impulsivity that contributes, but is not identical, to the exhibition of these difficulties in natural settings (Halperin et al., 1991).

Clinic-based scores may account for only a portion of the variance of these behaviors. Second, the type of responses required on the CPT and MFFT bear minimal correspondence with children's impulsive and inattentive behaviors exhibited at home or at school (Barkley, 1991). Third, children's ADHD-related behaviors may differ as a function of the greater novelty and higher frequency of performance feedback inherent to the clinic setting (Barkley, 1990). Fourth, rating scales typically collapse observations across extended time periods (e.g., several weeks to 6 months), whereas clinic tests usually take less than 15 min to complete. Thus, repeated testing procedures may be necessary to obtain a sample of behavior equivalent to that available for other assessment measures (Barkley, 1990). Finally, given that children with ADHD are a heterogeneous group, it is unlikely that a single test or combination of tests assessing specific areas of functioning will account for large amounts of behavioral variance in this group (Halperin et al., 1991).

Several factors limit conclusions based on these results. First, the use of a clinic-referred sample resulted in a restricted range for the clinic test and rating scale data thus deflating the size of the correlations among these measures. Previous studies which have obtained greater correlations between clinic test scores and parent and teacher ratings have used nonreferred school populations (e.g., Halperin et al., 1988). Despite the problem of restricted range, it is clinically relevant to note the minimal association between clinic test scores and ratings of inattention and hyperactivity within a sample of children with ADHD.

A second factor limiting these results was the use of parent interview responses and behavior rating scales as the classification "standards" against which the CPT and MFFT were compared. Even though diagnostic interview and rating scale data are consistently recommended as the core components of the evaluation of ADHD (Barkley, 1988b; Guevremont, DuPaul, & Barkley, 1990; Schaughency & Rothlind, 1991), they are not without limitations to their reliability and validity (see Barkley, 1988c). Nevertheless, these measures possess some degree of "face" ecological validity because parents and teachers typically are the referral agents. A third limitation of this study was the calculation of classification hit-rates based on a sample consisting only of clinically diagnosed children with ADHD. Because the study was conducted in a tertiary-care clinic specializing in ADHD, relatively few nonADHD children were available to participate. This limited the opportunity to calculate additional classification statistics such as positive predictive power and negative predictive power (Milich, Widiger, & Landau, 1987). Finally, these results are limited to the MFFT and the Gordon version of the CPT and are not necessarily generalizable to other similar clinic-based tests (e.g., Children's Checking Task; Margolis, 1972) that have been used in the assessment of ADHD. Nevertheless, the ecological validity of most clinic tests for the purpose of ADHD diagnosis has been found to be low to moderate, at best (Barkley, 1991).

The limited utility of this version of the CPT and the MFFT in the diagnosis of ADHD suggests the need for measures of sufficient ecological validity, which can be used in conjunction with parent and teacher report. The potential biases of the latter must be balanced through the use of more objective measures of ADHD symptoms. For example, analog observation systems have been found to discriminate between ADHD and normal children and to be associated with behavior ratings to a greater degree than traditional clinic tests such as the CPT and MFFT (Barkley, 1991). The clinical use of these coding systems appears promising and is primarily limited, at the present time, by a lack of adequate normative data. Thus, the most prudent course for future research is the development of clinic-based assessment methods that involve the coding of ADHD-related behaviors (e.g., being off-task, fidgeting) on several, separate occasions while the child is engaged in a task or activity that is very similar to those encountered in home or classroom settings.

References

- Achenbach, T. M., & Edelbrock, C. S. (1983). *Manual for the Child Behavior Checklist and Revised Child Behavior Profile*. Burlington, VT: University Associates in Psychiatry.
- Achenbach, T. M., & Edelbrock, C. S. (1986). *Manual for the Teacher Report Form and the Child Behavior Profile*. Burlington: University of Vermont, Department of Psychiatry.
- Altepeter, T. S., & Breen, M. J. (1989). The Home Situations Questionnaire and the School Situations Questionnaire: Normative data and an evaluation of psychometric properties. *Journal of*

Psychoeducational Assessment, 7, 312-322.

- American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders* (3rd ed., rev.). Washington, DC: Author.
- Barkley, R. A. (1987). The assessment of attention deficit hyperactivity disorders. *Behavioral Assessment*, 5, 207-233.
- Barkley, R. A. (1988b). Attention deficit disorder with hyperactivity. In E. J. Mash & L. G. Terdal (Eds.), *Behavioral assessment of childhood disorders* (2nd ed., pp. 69-104). New York: Guilford.
- Barkley, R. A. (1988a). Attention. In M. Tramontana & S. Hooper (Eds.), *Issues in child clinical neuropsychology* (pp. 145-176). New York: Plenum.
- Barkley, R. A. (1988c). Child behavior rating scales and checklists. In M. Rutter, A. H. Tuma, & I. S. Lann (Eds.), *Assessment and diagnosis in child psychopathology* (pp. 113-155). New York: Guilford.
- Barkley, R. A. (1990). *Attention deficit hyperactivity disorder: A handbook for diagnosis and treatment*. New York: Guilford.
- Barkley, R. A. (1991). The ecological validity of laboratory and analogue assessment methods of ADHD symptoms. *Journal of Abnormal Child Psychology*, 19, 149-178.
- Barkley, R. A., DuPaul, G. J., & McMurray, M. B. (1990). A comprehensive evaluation of attention deficit disorder with and without hyperactivity as defined by research criteria. *Journal of Consulting and Clinical Psychology*, 58, 775-789.
- Barkley, R. A., DuPaul, G. J., & McMurray, M. B. (1991). Attention deficit disorder with and without hyperactivity: Clinical response to three dose levels of methylphenidate. *Pediatrics*, 87, 519-531.
- Barkley, R. A., & Edelbrock, C. S. (1987). Assessing situational variation in children's problem behaviors: The Home and School Situations Questionnaires. In R. J. Prinz (Ed.), *Advances in behavioral assessment of children and families* (Vol. 3, pp. 157-176). Greenwich, CT: JAI.
- Brown, R. T. (1982). A developmental analysis of visual and auditory sustained attention and reflection-impulsivity in hyperactive and normal children. *Journal of Learning Disabilities*, 15, 614-618.
- Brown, R. T., & Wynne, M. E. (1984). An analysis of attentional components in hyperactive and normal boys. *Journal of Learning Disabilities*, 17, 162-166.
- Campbell, S. B. (1974). Cognitive styles and behavior problems of clinic boys: A comparison of epileptic, hyperactive, learning-disabled, and normal groups. *Journal of Abnormal Child Psychology*, 2, 307-312.
- Conners, C. K. (1985). The computerized Continuous Performance Test. *Psychopharmacology Bulletin*, 21, 891-892.
- Douglas, V. I., & Peters, K. G. (1979). Toward a clearer definition of the attentional deficit of hyperactive children. In G. A. Hale & M. Lewis (Eds.), *Attention and cognitive development* (pp. 173-248). New York: Plenum.
- Draeger, S., Prior, M., & Swanson, A. (1986). Visual and auditory attention performance in hyperactive children: Competence or compliance? *Journal of Abnormal Child Psychology*, 14, 411-424.
- DuPaul, G. J. (1991). Parent and teacher ratings of ADHD symptoms: Psychometric properties in a community-based sample. *Journal of Clinical Child Psychology*, 20, 245-253.
- Fischer, M., Barkley, R. A., Edelbrock, C. S., & Smallish, L. (1990). The adolescent outcome of hyperactive children diagnosed by research criteria: II. Academic, attentional, and neuropsychological status. *Journal of Consulting and Clinical Psychology*, 58, 580-588.
- Fuhrman, M. J., & Kendall, P. C. (1986). Cognitive tempo and behavioral adjustment in children. *Cognitive Therapy and Research*, 10, 45-50.
- Gordon, M. (1983). *The Gordon Diagnostic System*. DeWitt, NY: Gordon Systems.
- Gordon, M. (1986). How is a computerized attention test used in the diagnosis of attention deficit disorder? *Journal of Children in Contemporary Society*, 19, 53-64.
- Gordon, M., DiNiro, D., & Mettelman, B. B. (1988). Effect upon outcome of nuances in selection criteria for ADHD/hyperactivity. *Psychological Reports*, 62, 539-544.
- Guevremont, D. C., DuPaul, G. J., & Barkley, R. A. (1990). Diagnosis and assessment of attention deficit-hyperactivity disorder in children. *Journal of School Psychology*, 28, 51-78.
- Halperin, J. M., O'Brien, J. D., Newcorn, J. H., Healey, J. M., Pascualvaca, D. M., Wolf, L. E., & Young, J. G. (1990). Validation of hyperactive, aggressive, and mixed hyperactive/aggressive childhood disorders: A

- research note. *Journal of Child Psychology and Psychiatry*, 31, 455-459.
- Halperin, J. M., Sharma, V., Greenblatt, E., & Schwartz, S. T. (1991). Assessment of the continuous performance test: Reliability and validity in a nonreferred sample. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*, 3, 603-608.
- Halperin, J. M., Wolf, L. E., Pascaulvaca, D. M., Newcorn, J. H., Healey, J. M., O'Brien, J. D., Morganstein, A., & Young, G. (1988). Differential assessment of attention and impulsivity in children. *Journal of the American Academy of Child and Adolescent Psychiatry*, 27, 326-329.
- Hollingshead, A. B. (1975). *Four factor index of social status*. New Haven, CT: Yale University, Department of Sociology.
- Homatidis, S., & Konstantareas, M. M. (1981). Assessment of hyperactivity: Isolating measures of high discriminant ability. *Journal of Consulting and Clinical Psychology*, 49, 533-541.
- Kagan, J. (1966). Reflection-impulsivity: The generality and dynamics of conceptual tempo. *Journal of Abnormal Psychology*, 71, 17-24.
- Klee, S. H., & Garfinkel, B. D. (1983). The computerized Continuous Performance Task: A new measure of inattention. *Journal of Abnormal Child Psychology*, 11, 487-496.
- Lovejoy, M. C., & Rasmussen, N. H. (1990). The validity of vigilance tasks in differential diagnosis of children referred for attention and learning problems. *Journal of Abnormal Child Psychology*, 18, 671-681.
- Margolis, J. S. (1972). *Academic correlates of sustained attention*. Unpublished doctoral dissertation, University of California, Los Angeles.
- Milich, R., & Kramer, J. (1984). Reflections on impulsivity: An empirical investigation of impulsivity as a construct. In K. Gadow & I. Bialer (Eds.), *Advances in learning and behavioral disabilities* (Vol. 3, pp. 117-150). Greenwich, CT: JAI.
- Milich, R., Widiger, T. A., & Landau, S. (1987). Differential diagnosis of attention deficit and conduct disorders using conditional probabilities. *Journal of Consulting and Clinical Psychology*, 55, 762-767.
- Pascaulvaca, D. M., Wolf, L. E., Healey, J. M., Tweedy, J. R., & Halperin, J. M. (1988, January). *Sex differences in attention and behavior in school-age children*. Paper presented at the meeting of the International Neuropsychological Society, New Orleans.
- Rosvold, H. E., Mirsky, A. F., Sarason, I., Bransome, E. D., & Beck, L. H. (1956). A continuous performance test of brain damage. *Journal of Consulting and Clinical Psychology*, 20, 343-350.
- Salkind, N. J., & Nelson, C. F. (1980). A note on the developmental nature of reflection-impulsivity. *Developmental Psychology*, 6, 237-238.
- Schaughency, E. A., & Rothlind, J. (1991). Assessment and classification of attention deficit hyperactive disorders. *School Psychology Review*, 20, 187-202.
- Shapiro, S. K., & Garfinkel, B. D. (1986). The occurrence of behavior disorders in children: The interdependence of attention deficit disorder and conduct disorder. *Journal of the American Academy of Child Psychiatry*, 25, 809-819.
- Sostek, A. J., Buchsbaum, M. S., & Rapoport, J. L. (1980). Effects of amphetamine on vigilance performance in normal and hyperactive children. *Journal of Abnormal Child Psychology*, 8, 491-500.
- Sykes, D. H., Douglas, V. I., & Morganstern, G. (1973). Sustained attention in hyperactive children and the effect of methylphenidate (Ritalin). *Journal of Child Psychology and Psychiatry*, 14, 213-220.
- Wechsler, D. (1974). *Wechsler Intelligence Scale for Children—Revised*. New York: Psychological Corporation.
- Werry, J. S., Elkind, G. S., & Reeves, J. C. (1987). Attention deficit, conduct, oppositional, and anxiety disorders in children: III. Laboratory differences. *Journal of Abnormal Child Psychology*, 15, 409-428.